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ABSTRACT

The focus of this study was to understand and describe the nature of a professional community of interdisciplinary science teachers linked together through a telecommunications network. Thirty two high school science teachers participated in a 2 week summer institute. Patterns of teacher participation and changes within this community were detected from the frequency and use of electronic mail, bulletin boards, conferencing, and software sharing. The high school science teachers from this study spent a minimum of 2 hours per week becoming acquainted with a commercial telecommunications system for one month prior to a summer institute and continued to interact with one another during their school year following the summer program. Interactions on-line were coordinated, collected, and supported by the community's facilitator. Pre-workshop electronic activities included tasks to assist teacher familiarity with the network, public bulletin board sections for socializing, sharing resources, and obtaining information about the workshop. Post-workshop interactions have been initiated by the teachers and coordinated by the facilitator and other workshop staff to include professional support for: resources for classroom maintenance, new classroom strategies, and opportunities for sharing teacher resources. These preliminary results indicate a strong potential for developing a collaborative community of professional practitioners. Contains 48 references. (Author)

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A PILOT STUDY OF AN ELECTRONIC COMMUNITY OF INTERDISCIPLINARY SECONDARY SCIENCE TEACHERS

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A PILOT STUDY OF AN ELECTRONIC COMMUNITY OF INTERDISCIPLINARY SECONDARY SCIENCE TEACHERS

Paper Presented at
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Abstract

The focus of this study is to understand and describe the nature of a professional community of interdisciplinary science teachers linked together through a telecommunications network. Thirty two high school science teachers participated in a two week summer institute. Patterns of teacher participation and changes within this community were detected from the frequency and use of email, bulletin boards, conferencing, and software sharing. The high school science teachers from this study spent a minimum of 2 hours per week becoming acquainted with a commercial telecommunications system for one month prior to a summer institute and continued to interact with one another during their school year following the summer program. Interactions on-line have been coordinated, collected, and supported by the community's facilitator. Pre-workshop electronic activities included tasks to assist teacher familiarity with the network, public bulletin board sections for socializing, sharing resources, and obtaining information about the workshop. Post-workshop interactions have been initiated by the teachers and coordinated by the facilitator and other workshop staff to include professional support for: resources for classroom maintenance, new classroom strategies, and opportunities for sharing teacher resources. These preliminary results indicate a strong potential for developing a collaborative community of professional practitioners.

Purpose

Electronic networking in education evolves for various purposes; such as providing a support system for preservice teachers (Bull *et al.*, 1989, Merseth, 1988); providing a collaborative network of practicing teachers with general resource opportunities, support, and interactions (Kimmel, *et al.*, 1988; Collis, 1992; Access Excellence, 1994; Brush, Knapczyk and Hubbard, 1993; Honey and Henriquez, 1993); providing teachers with an opportunity to develop curriculum materials (Dempsey, 1985; Katz *et al.*, 1987; Walker, 1987; Mann, 1989; Lehman, *et al.*, 1992; Olds and Pearlman, 1992; and Broholm, 1993); performing inservice programs (Kimmel *et al.*, 1988); and encouraging students and teachers to interact globally (Hassard and Weisburg, 1992).

These different types of networks can be categorized as 1. administrative networks, local area networks bringing teachers within a school, district and state, together to assist in management and other administrative activities (Broholm, 1993; Drayton, 1993); 2. multi-purpose networks which enjoin teachers and students with other groups across the country, performing research, sharing ideas, and participating in activities (West and McSwiney, 1989; Weir, 1990; Hassard and Weisburg, 1992; Julyan, 1993); and 3. a teacher network for

teaching, developing a community of practice (Merseth, 1988; Bull *et al.*, 1989; Mann, 1989; Drayton, 1993). Some consider this third type of network rare (Drayton, 1993); however, these types of networks have existed and been successful. Long term research into these networks is scarce.

Some of these networks have been maintained successfully and some have failed. Various researchers have analyzed and compared different networks, trying to identify strategies that will foster the development of telecommunication networks (Riel and Levin, 1990; Collis, 1992; Weir, 1992). Moreover, Riel and Levin (1990) provided an analysis of factors that appear critical for planning a global community. After a careful analysis of the literature, it became clear that these factors, termed "participant structures," appear in other research on electronic communities of teachers, as depicted in Table 1. These structures lend to isolating features that contribute to successful patterns of interactions. The organization of the network group includes the participants in a network, as well as the attributes they bring such as their experiences, interests, and expertise which affect the relationships that evolve in the group. Another aspect of the network is the task organization, or the context, which could be as broad as sharing ideas or as specific as contributing toward a goal. However, there are other essential aspects to consider, which include access not only to the network but also equipment, the medium for communication, and the response opportunities available for the networked group. Riel and Levin also describe other attributes, such as response obligations, which consist of intrinsic or formal statements of obligations that influence the wait time between responding to messages. Another structural component is the coordination and evaluation of the quality and quantity of interactions. Our results indicate that these factors provide not only a structural framework for this community but also provide a means for identifying the relationships / interactions between these structures which ultimately affect the development of this community.

Research indicates that successful teacher programs provide support in the school context (Baird, Ellis and Kuerbis, 1989; Lieberman, 1990). Such programs often rely on communities of networks to sustain the assistance they need as teachers develop a new set of norms and expectations (Wigginton, 1989; Flinn, 1982; and Mann, 1989). The community constructs new meanings (Lemke, 1989). Communities of teachers develop relationships with one another to enhance their personal and professional development while collaborating with colleagues (Lieberman, 1990).

Although there are several types of electronic networks, limited research about networked teacher communities exists. Can teacher networks develop into a community of professional practice? And would such a community be adequate for describing a group of teachers coming together through telecommunications after becoming re-educated and re-

Participant Structures	Reported Factors Important to Success of Networks
Organization of network group	Preservice teachers (Bull et al., 1989; Merseth, 1988) Inservice teachers (Kimmel *et al.*, 1988) Familiarity with participants (Kresky and Gal, 1992)
Task organization	Training (Hamilton & Thompson, 1991; Bull *et al.*, 1990; Collis, 1992, Marantz, and England, 1993) Sensitive to needs over time (Collis, 1992) Build partnership & trust (Knapczyk *et al.*, 1993; Riel and Levin, 1990; Bull *et al.*, 1990) Resource networks (Kimmel, *et al.*, 1988; Collis, 1992; Brush, Knapczyk and Hubbard, 1993; and Honey and Henriquez, 1993) Develop curriculum materials (Dempsey, 1985; Katz *et al.*, 1987; Walker, 1987; Mann, 1989; Lehman, *et al.*, 1992; Olds and Pearlman, 1992; and Broholm, 1993) Preservice programs (Bull et al., 1989; Merseth, 1988) Inservice programs (Kimmel *et al.*, 1988) Community of practice (Drayton, 1993; West and McSwiney, 1993)
Response opportunities	Financial support (Honey and Henriquez, 1993) Schedule for use home/school (Kresky and Gal, 1992; Thompson & Hamilton, 1991; Merseth, 1990; Bull et al., 1989) Phone line use (Thompson & Hamilton; Honey & Henriquez 1993) Lack of equipment (Thompson & Hamilton, 1991) Accessibility (Hamilton & Thompson, 1992 Broholm, 1993) Time (Hassard & Weisburg, 1992; Honey & Henriquez, 1993; Kresky and Gal, 1992; Merseth, 1990; Thompson & Hamilton, 1991; Weir, 1992; Drayton, 1993)
Response obligations	Efficient use (Newman, 1992; Julyan, 1993)
Evaluation / coordination	Moderator (Merseth, 1990; Mann, 1990; Hassard and Weisburg, 1992; Broholm, 1993) Surveys (Merseth, 1990; Broholm, 1993; Drayton, 1993)

Table 1 Summary of factors for determining the success of a telecommunications network, as compiled from the literature. This framework is based on a research strategy obtained from Riel and Levin, 1990.

socialized through an inservice program? This study considers these questions by documenting and analyzing the frequency and use of email, bulletin boards, teleconferencing, and software sharing to depict the growth and development of a group of electronically networked science teachers: 1. interacting before a summer inservice program, and 2. over time after they leave and begin to implement new curriculum from the program. It is clear from previous research that electronic communities introduce teachers to a new social setting with the potential for a new means of professional development.

Research Design

Participants

The members of this networked community were categorized as either primary or secondary participants. The science teachers, selected for a two week, National Science Foundation-funded summer inservice program termed Patterns in Nature (PIN), were categorized as primary participants. Thirty two teachers, 19 males and 13 females, were selected based on leadership qualities (prior participation in curriculum development and teacher workshops), number of years of teaching experience, and a letter of support from the school principal / superintendent (indicating that the teacher would have access to computer materials for their classroom and the network). Teaching experiences ranged from 1-28 years, with a mean of 10 years, and teacher expertise varied across the disciplines - earth science, physics, chemistry and life science. There were 21 biology teachers, 3 chemistry teachers, 4 physics teachers, and 2 earth science teachers. Nine teacher participants also taught a science outside their primary discipline.

The secondary participants included support staff who organized and carried out the summer program. They supported primary participants during the two-week program, guiding them to become familiar with content about interdisciplinary science, as well as new applications for computer technology in the classroom ranging from concept mapping and learning logs to computer simulations, scanners, and video microscopy. The secondary participants consisted of project directors in science and science education; scientists who researched and developed the educational materials; technical experts with computer knowledge and experience; four high school science teachers who pilot tested the Patterns in Nature materials over the past 5 years; and two research associates who facilitated the telecommunications interactions activities with primary and other secondary participants. The research associates became the facilitators who supervised all telecommunication activities before and after the inservice program, were responsible for coordinating and evaluating electronic activities, organized conferences, and

provided teachers with updated administrative details or other activities and corresponding with teachers on a daily basis.

Commercial Network

The commercial network, serving as the telecommunication interface with various response opportunities, was America OnLine (AOL). This network was chosen because it could be used with Macintosh computers, which were an essential part of the technology associated with this program. The network provided an interactive, self-teaching program, which functions similar to Macintosh-based word processing programs, less cumbersome than using other Unix-based systems, such as CompuServ.

AOL was also considered for its diversity of electronic opportunities and activities, i.e. email, bulletin boards, conferences, and access to internet. America OnLine provided the Patterns in Nature secondary participants with a bulletin board area, know as the Mac Education Forum, where several other bulletin boards were located. One of the technical advisors of the PIN program was active in AOL programs and coordinated the availability of these opportunities with AOL support personnel. In the Patterns in Nature section, there was a space for software libraries for uploading and downloaded large materials to be shared. Additionally, an introductory section and a weekly update section were created by the support staff for public viewing. Weekly update provided a weekly listing of events, reminders, and any public information pertinent to the Patterns in Nature group. The "Message Board" sections comprised the bulletin board system.

Sources and Analysis

This study documented the development of an electronic community of science teachers by observing the quantity and quality of telecommunication interactions from: 1. email responses sent directly to the facilitators or responses forwarded from other support staff; 2. bulletin board postings; 3. live conference sessions; and 4. interactions outside the electronic network (phone, postal mail, fax, or visits).

The frequency of email use was determined by: 1. email messages sent to the PIN address, 2. email surveys inquiring about the time teachers spent using email, and 3. an automated email trace sent with mail which served as a receipt indicating the date and time mail was read by the addressee.

The frequency of interactions from the different settings described above was documented over time (both prior to the inservice program and after). The time frame included pre-institute messages, fall messages (August - November), winter messages (December -

February), and spring messages (March). The quality of interactions were documented by compiling discourse from email correspondence, bulletins, and conferences over time. These transcripts were compared and the comments was categorized, and analyzed for the presence or absence of patterns in telecommunication activities using the software tool HyperResearch^{R} (Bogdan and Biklin, 1992).

The interactions from postings were observed and documented not only to determine the frequency and types of interactions in AOL, but also to document teacher interactions to consider what and how they used telecommunications.

Findings

The primary and secondary participants interacted through telecommunications prior to the summer institute, worked together in person for two weeks during the summer, and 28/32 have remained active using telecommunications (fall - spring). Active telecommunication users included those participants who interacted using any of the electronic opportunities supported through AOL: email, bulletin boards, and conferences.

More than half the primary participants were first-time telecommunication users; however, the training for new users was minimal. The primary participants received AOL registration packets, a PIN address, and daily assistance from the PIN facilitator. The facilitator directed people to the bulletin board, posted many responses to technical inquiries publicly, and encouraged pre-institute activity by providing pre-institute work / information, and by providing a two-hour AOL discussion / demonstration session during the summer institute with optional tutorial sessions.

After the two week summer program, the primary participants went back to their schools with some new knowledge and new technologies for the coming school year. Although the teachers were from several states across the United States, they had an opportunity to interact through telecommunications.

Email

Thirty one of the thirty two teachers interacted with the facilitators over the two months before the institute. The teacher who could not be on-line did not have access to a computer and modem until the following fall. The research associates continued as the facilitators who supervised all telecommunication activities, coordinated and evaluated electronic activities, updated primary participants with administrative details or other activities, and ensured that questions and concerns from primary participants were forwarded to the appropriate secondary participants on a daily basis.

Although 31 teachers were interacting through email before the institute, on average 17 teachers per month sent messages to the PIN address after the summer institute. However, email traces indicated that 27 teachers per month were utilizing their AOL email accounts. The number of primary participant-initiated (teacher) and secondary participant-initiated (facilitator, technical expert) interactions varied as shown in Table 2. All secondary participant-initiated topics involved administrative issues, while teacher-initiated messages dominated all the other categories. Some variation in participant-initiated messages occurred during the fall; however there was also a noticeable shift in similarities between percentile rank during the winter.

Type of interaction	Pre-Institute		Fall		Winter	
	P	S	P	S	P	S
Greetings	4	1	1	1	2	2
Administrative needs	1	2	5	2	1	1
Share resources	5	3	3	4	3	3
Needs	5	4	2	3	4	4
Telecommunications	1	5	4	5	-	-
Total messages sent	44	50	97	95	66	63
Participants on-line	31	3	18	5	19	6

Table 2. The categories of email interactions described in Figure 2 were further examined to determine the differences between categories initiated by primary participants (p) and secondary participants (S).The percentile ranks for these categories is indicated.

Compilation and categorization of these interactions over time indicated that there were five main types of messages sent to the facilitators. These interactions included administrative needs, greetings, telecommunications questions, sharing resources, and school resource needs. Figure 1 shows the total number of email interactions over time, including interactions prior to the summer institute, the following fall, winter, and spring. As this graph indicates, the majority of primary participant interactions with the facilitators were administrative needs, which included any discourse associated with activities initiated for the PIN program: preparing for the institute, inquiries about credit, contributing to the quarterly newsletter, requesting published worked or responding to secondary participant requests. Although administrative interactions

dominated email activity, the types of administrative activities varied over time as shown in Figure 2a.

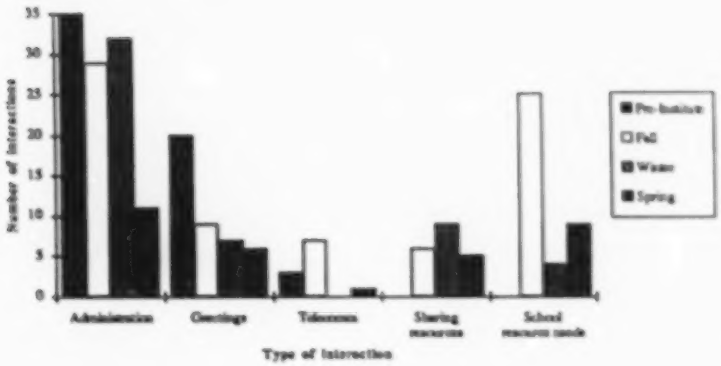

Figure 1 Categories of email interactions
The number and types of total email interactions sent to the PIN address were compiled and compared over time.

Figure 2a indicates two things: first, there was a change in the frequency of responses over time, and second, the content of administrative messages changed over time. During the months prior to the summer program, the majority of administrative interactions involved primary participant inquiries about program details, whereas during the fall messages included contributing to the fall newsletter or preparing for an on-line conference. All email inquiries or suggestions initiated by the PIN staff or the primary participants were acknowledged by a response within two days after receiving the message.

Other categories of email interactions, such as general greeting, consisted of smile faces, discussions about participants' feelings, sharing student accomplishments, or personal situations (Figure 2b). Sharing resources and school resource needs were also categorized as

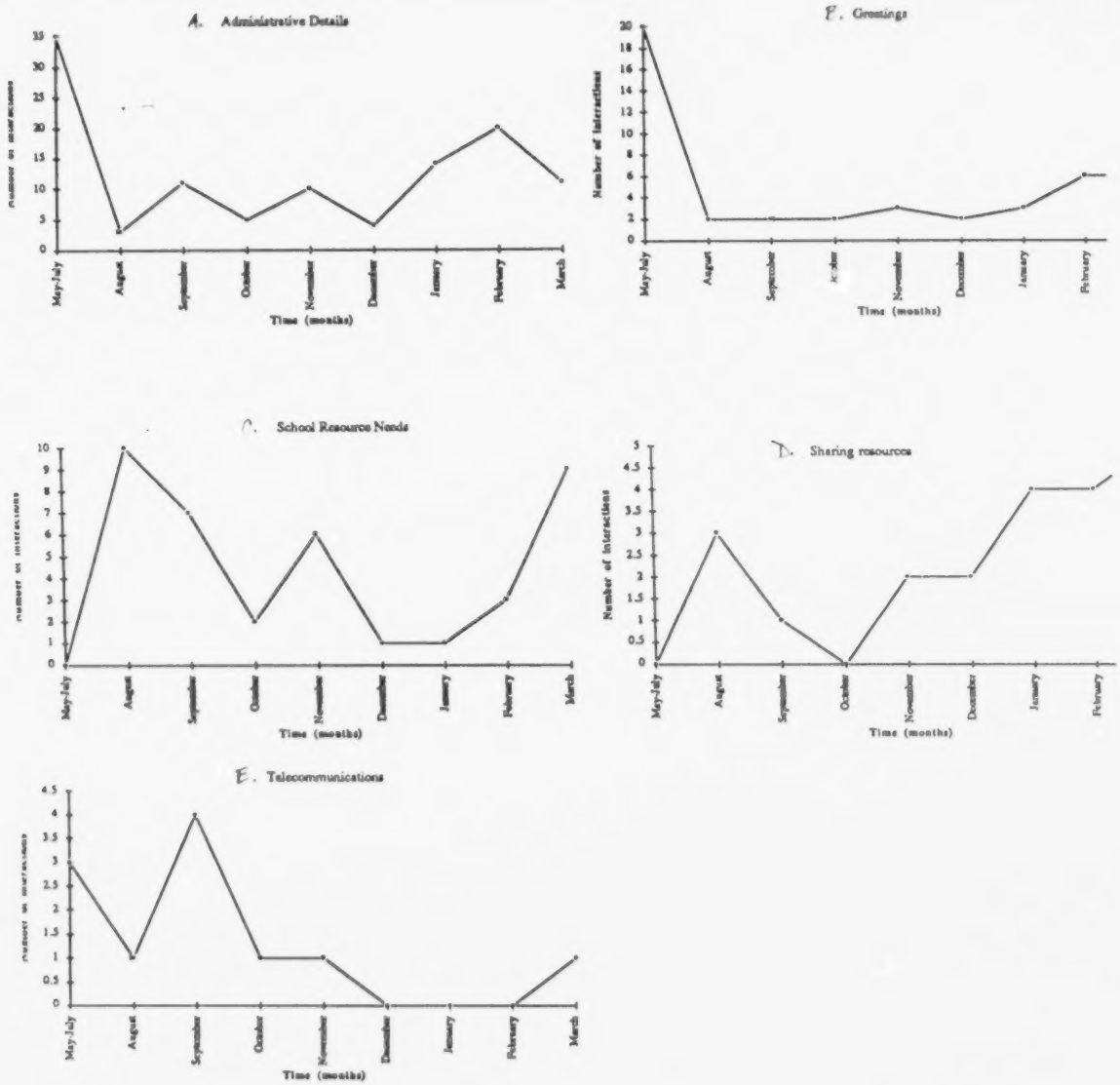

Figure 2 Patterns of email activity over time
These graphs show the overall trends in different types of primary participant email interactions. (A) Email pertaining to administrative needs decreased after the summer program and reached a somewhat steady state through fall and winter months. This type of trend was also typical of greetings (B). Trends appear different in both C & D, which imply some type of cycle between May and February (Please note the differences in scale between these two). The graph in (E) shows trends in interactions pertaining to topics about telecommunications. Many of the trends in email activity are affected by other response opportunities, like the bulletin board sections (E). For example, bulletin board sections containing messages about resource needs, appeared between August and January, which alters the overall trend in activity (A).

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interactions where primary participants shared information about PIN or other topics of interest with the secondary participants or needs included requests for assistance using or obtaining PIN materials for their schools. The content characteristic of all these types of messages, similar to the content of administrative needs (Figure 2a), varied in frequency and type over time.

Additionally, Figure 2c, 'school resource needs,' indicates a different pattern: an overall decline in the frequency of interactions that occurred per month. However, the frequency of messages was more erratic over time as compared to the frequency of messages in Figure 2a. For example, in Figure 2c, the responses were at a high in August (n = 10) but declined in October (n = 2) and displayed this trend again from November to February. In March it appeared to increase. However, the administrative and greeting messages were not so erratic: there was a decline, which leveled off (Figure 2a & b). Erratic or cyclic activity was also common to 'telecommunications,' and 'sharing resources' messages (Figure 2d-e). The frequency of email message exchange and the types of messages sent varied over time.

Additionally, the types of messages initiated by primary and secondary participants varied with time. Table 2 shows the percentile rank of those categories most frequently sent to the PIN address, as compared to those categories most frequently posted to the primary participants. The secondary messages include those messages posted in the weekly update section, by the facilitators as well as email sent from facilitators, scientists, directors, and pilot teachers.

Bulletin Board Sections

The PIN bulletin board was a public area in the Mac Education Forum of AOL where primary or secondary participants created new sections or folders in the bulletin board to which anyone could post messages, as indicated in Figure 3. This figure shows a chronology of the sections in the PIN bulletin board including the date a section was created, the title of the section, the creator, and use of a particular section.

Prior to the summer institute all sections were created by secondary participants, primarily the facilitators. The facilitators encouraged bulletin board activity by monitoring 1. when the teachers mentioned similar requests or comments from email interactions with the facilitator; 2. when a single teacher commented about topics relevant to the group; or 3. when support staff members discussed ways of promoting interactions in the bulletin board. During the fall, 25% of the sections were created by primary participants and during the winter all sections were created by primary participants. The 'Activities' section contained the greatest number of postings before the summer institute despite the fact that more participants posted messages in the section, 'Introduce Yourself' (see Figure 4). However, during the fall other sections appeared and became more readily used such as the technology section and the school

section (Figure 4). The secondary participants also interacted in the different sections of the bulletin board, averaging from 0-5 secondary participants per section.

Date of origin	Title of section	Creator	Use for community
June	Introduce Yourself	S	Introductions
June	Comments	S^{f}	Topics for conversations
June	What's Coming Up	S^{f}	Place to archive announcements
July	Activities in Boston	S^{f}	Planning summer activities
August	Telecommunications	P	Share information about telecommunication topics
August	PINS in Science	S	Share current science research topics
August	Learning Logs	S^{pt}	Assist members using new pedagogy
August	Technology	S	Support for using PINS technology
September	School	S^{f}	Talk about the start of the new school year
September	Curriculum	P	Discussions about curriculum
September	Chat on line	S^{f}	Planning for upcoming AOL conferences
November	AOL Information	S^{f}	Support for email technical assistance
December	Concept maps	P	Discuss / share experiences using new pedagogy
December	BioPINS	P	Discuss / share information about biology
January	Physical science stuff	P	Discuss / share information / about physical science
February	NSTA Convention	P	Planning for the 95 NSTA convention
February	National Educ. Supercomputer	P	Discuss / share experience with Super computer technology
March	PINs workshop	P	Discuss / share workshop strategies and experiences
March	PINs references	P	Share reference materials related to PIN topics / activities

Figure 3 Chronology of bulletin board sections
A summary of the bulletin board sections: the time when the section appeared; the title of the section both pre-institute and post-institute; the 'creator' of each section; and the purpose of each section. P represents primary participant, S represents secondary participant, f represents facilitator, pt represents pilot teacher.

Each bulletin board section also contained a variety of comments as indicated in Figure 5. The categories describe the general types of discourse that appeared in postings from different sections of the bulletin board: planning events; interpersonal thoughts; talk between two or more people (cross talk); sharing ideas and advice (resources); sharing experiences or reflections about experiences; and inquiring or stating school needs. Figure 5a displays the number of different types of postings in each section and clearly shows that differences in the overall content of postings existed in bulletin board sections.

Figures 5b&c indicate more subtle differences that evolved over time. For example, in the 'school' section the majority of discourse involved sharing experiences. Additionally, the types of experiences that teachers shared also varied, as listed in Figure 5b. However, the discourse in the 'technology' section was dominated by messages involving school needs, cross talk, and sharing resources. Thus, it is clear that different bulletin board sections contained different patterns of activity.

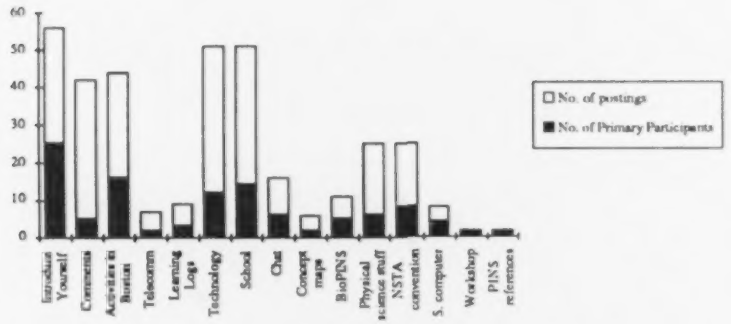

Figure 4 Timeline of postings in bulletin board sections
A summation of postings and teachers posting messages from the bulletin board sections that appeared over time (pre-institute through spring).

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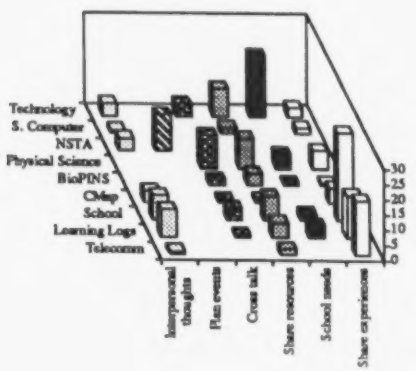
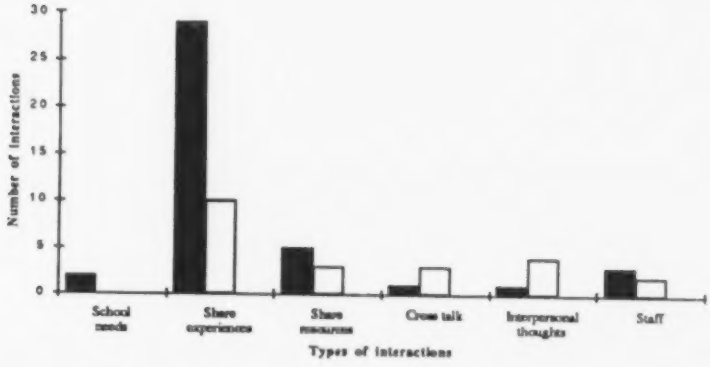
A.



B.



C.

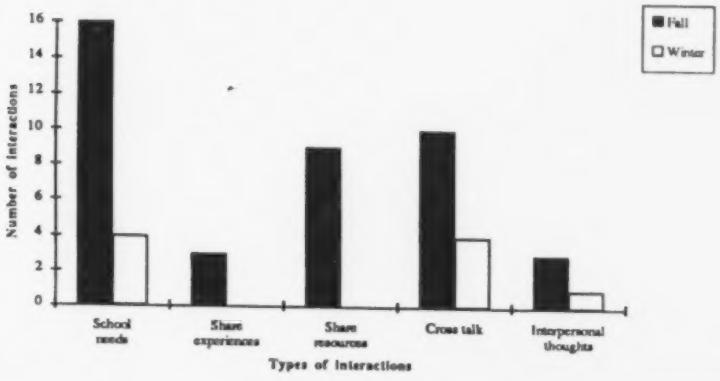


Figure 5 Patterns of bulletin board interactions
(A) The content from the postings in Figure 4 were compiled and categorized by the types of interactions, indicated in the column graph. (B) A closer analysis of the school section indicates that there is a change in the numbers and types of interactions in the postings from fall to spring. (C) "Technology" section A closer analysis of the technology section indicates that there is a change in the numbers and types of interactions in the postings from fall to spring.

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The "Weekly Update" area could be read by the primary and secondary participants; it was maintained by the facilitators, who created weekly memos to inform the community about upcoming events, administrative changes, science activities, and special announcements. No one could post a message to these areas; rather it was a place where people became informed about issues. Often the facilitators encouraged members of the community to create new sections in the bulletin board. These sections were summarized at the close of the month and archived as a bulletin board section for those who needed to refer back or for those who had missed new information.

The software libraries allowed documents larger that email notes to be uploaded and stored. If people were interested in an item, they could download it from this area. PIN newsletters, copies of on-line PIN conferences, and some teacher shareware existed here. All participants were notified when new things were posted via an announcement posted in the "Weekly Update" section.

Conclusions

Teachers participating in the Patterns in Nature summer program socialized and planned their visits before arriving for a 'face-to-face' summer program and left the program with new materials with the option of interacting through telecommunications. Approximately three quarters of the group continued to interact electronically. The interactions through telecommunications changed as teachers discussed plans or began implementing PIN materials in their schools. The context for this community has allowed it to evolve into an environment that offers teachers the opportunity to interact personally, socially, and professionally sharing their thoughts, seeking advice, sharing their experiences with their successes and problems in implementing new curriculum materials (Figures 1&4).

The context for this community depended on the structure of the network, as described previously (Table 1). As Philips (1975) and Riel and Levin (1990) have reported, there is some underlying framework that affects the interactions in both classroom and electronic environments. These structures can be categorized as the participant organization, the response opportunities, task organization, response obligation, and evaluation / coordination. The participant organization was subdivided into two categories; primary and secondary participants. The teachers who attended the summer institute, with various backgrounds, experiences, and geographical locations, were categorized as the primary participants who were interested in learning about new ways of bringing technology and science into their classrooms. The facilitators, the scientists, technical personnel, and original pilot teachers comprised the secondary participant group who were interested in introducing their work to educators,

providing guidance and support for teachers, and obtaining feedback to improve the use of these materials. The secondary participants represented the Patterns in Nature program, whose primary concerns were assisting the teachers as they implemented new PIN materials, pedagogy, technology, and new content knowledge. These differences between the goals of primary and secondary participants are illustrated in Table 2; those email messages initiated by the primary participants were responded to most by teachers, even as the focus of categories, such as administrative needs, changed from preparing for the summer program, to sharing experiences for to contributing to a newsletter.

The response opportunities include email, bulletin board, and conference options. As indicated in Table 2 and Figure 4, several members of the group were regularly involved in these opportunities. These resources were provided by the structure of the network. Public interactions through the bulletin board sections provided primary and secondary participants with opportunities to share ideas, state needs, provide announcements, and plan events. For example, in the 'Activities' section of the bulletin board, 16 teachers spent time posting notes to one another describing their hobbies and activities they enjoyed. A group of 5 people planned a time and place to meet to watch the World Cup Soccer Finals; 20 teachers eventually joined together to watch the event. Different sections seemed to become meeting places where various types of discourse or meanings were created (see Figure 4). The bulletin boards, conferences, and email interactions disclosed interpersonal, professional, and pedagogical activities.

Patterns of Interactions

Two patterns are common in all forms of response opportunities: first, there were changes in the frequency of responses/postings over time, and second, there were changes in the types and content of messages over time. These changes were influenced by interactions and needs between the primary and secondary participants and opportunities supported by the network.

For example, the numbers of 'school resource needs' email messages were erratic over time (Figure 2c). The sharp decline indicated in the fall and winter corresponded to the appearance of new bulletin board sections. The majority of needs from the fall sought technical advice about technology in the teachers' schools; the facilitators forwarded these messages to technical experts, but because of the number and similarity in questions the technical expert created a section in the bulletin board (Technology questions). The number of technology-related requests through email disappeared and the email interactions decreased. A more careful examination of the technology section (Figure 5c), shows that as the technology-related postings decreased during the winter (as compared to the fall months) that primary participants'

needs were changing from inquiries about organizing technology in their classrooms to inquiries about other resource needs.

Consider Figure 2c: there was a decline in messages in December, at a time when teachers were creating BioPINS, Concept Mapping, and Physical Science sections in the bulletin board (compare Figure 2c with Figure 3). Occasionally teachers would send a message, sharing new discoveries or inquiring about PIN content knowledge or PIN lab accessories; these types of messages also appeared in new sections of the bulletin board, mentioned above. The development of this bulletin board section was considered through evaluation of the teachers' needs and coordination to create a way of meeting their needs. And such changes e.g. creating new bulletin board sections. corresponded to the erratic activities shown in Figure 2c-e. The sharp decline in email messages occurred as bulletin board sections became more widely used.

Furthermore, these three sections (BioPINS, Concept Mapping, and Physical Science) were created by primary participants (see Figure 3). After reviewing the fall evaluation of teacher opinions about PIN on AOL the facilitators noticed that some teachers indicated interest in discipline-specific areas of the bulletin board. Consequently, the facilitators sent an email memo encouraging them to create a new section with their assistance if necessary. Again this activity followed a literal evaluation created by the facilitators and also demonstrates the relationship between 'responses obligations' and the participant structures. This change in events may also relate to the changing focus of email initiated by secondary participants during the winter (Table 2) and the shift in participant establishment of 100% of the bulletin board sections by winter (Figure 3). Such activities may indicate the beginnings of a new phase in the development of this community, as primary participants take on other roles in the community.

After evaluating the participant surveys during the late fall, the facilitators gained more insight about teacher needs and tried to accommodate those needs, which may also explain the similarities in percentile ranks as shown in Table 2. The facilitators and scientists diligently followed-up teacher messages, acknowledging all teachers' 'shared resources' from email interactions and resource needs from both email and bulletin board interactions. However, at no time were strict regulations about response obligations set. Most teachers sent 'general greetings,' which indicated their appreciation and some teachers did respond to evaluations and participation in newsletters.

The different sections in the bulletin board also revealed characteristic types of postings, such as the NSTA section being used to plan activities at a meeting, or the physical science section being used to share experiences, and seek advice about resources from one's discipline

(see Figure 5a). The types of interactions in the different sections depended on both the response opportunities available as well as the interests of the participants.

The way that the participant organization and response opportunities were affiliated with one another influenced the response obligations, evaluation / coordination activities, and ultimately the maintenance of the task organization in this community. The task organization, or focus of the group, is a reflection of the social practices and processes which the participant organization and opportunities provide. In a sense the task organization is actually a social construction. The origin of bulletin board sections, such as the 'technology' section, along with the changing needs in the community, exist because they have some meaning to participant members of the community. As a result, these meanings (such as advice about buying and organizing hardware) become practices in the group such as a section in the bulletin board where participants post concerns, share resources, and share experiences.

Figure 6 shows a concept map of the organizational structures and demonstrates how interactions have proved essential to maintain this community. The structure of this community appears to foster a setting allowing teachers to collaborate and gain external support as they implemented and shared new curriculum content in the culture of their schools. These types of task organizations were possible because the community structure was flexible enough to support changes over time, indicating the importance of a formative community being able to meet the changing needs of a culture.

Establishing and maintaining a network of teachers is not a small task. For example, it is important to consider the time and effort that participants put into aspects of the community such as: the negotiations to organize the opportunity to have an electronic network, the meetings between secondary participants coordinating and evaluating the activities and growth of the community, and the 30 hours of time per week spent by facilitators interacting with participants, evaluating and coordinating various tasks. 27 teachers are presently using their email accounts but 5 teachers have not interacted since the summer program. We are currently trying to determine reasons for this situation and ways of preventing them in the future. It is also important to consider the medium for the network. The response opportunities are provided by America OnLine, a commercial network. Education is not the AOL's primary interest. Initially there were some problems when they refused to reimburse primary participants. Presently the PIN program is preparing to bring 64 new teachers together electronically but AOL may refuse to continue to provide financial support for the community. As with any networked community there will be obstacles to overcome; however, it is important to consider these issues and situations as they relate to the task organizations established by the participants and response opportunities present.

The participant structures merge together to create the meaning, the task organization of this community. The task organization provides a context allowing participants to collaborate, share experiences and resources or seek advice (see Figure 6). Presently we are considering how meanings of this community developed between the participants and response opportunities in more detail. For example another teacher evaluation / survey was sent to the primary participants to determine how their experiences with an electronic community has affected their professional lives. Other preliminary findings suggest that conferencing on-line offers yet another type of opportunity for the primary and secondary participants (not discussed in this paper). It is also important to consider how individuals use the context of this community for their own growth and development.

The development of a community of practicing teachers can have a major impact on educational practice. "Communities are systems whose types can evolve because the material base of their [cultural] practices can preserve information, accommodate variability and transmit information to future communities" (Lemke, 1990, p.210). This piece of work merely provides a glimpse of some aspects of the "material base" and developments associated with an electronic community. Together with the complexity and power of telecommunications a new social context, may evolve for collaboration of communities of practicing teachers.

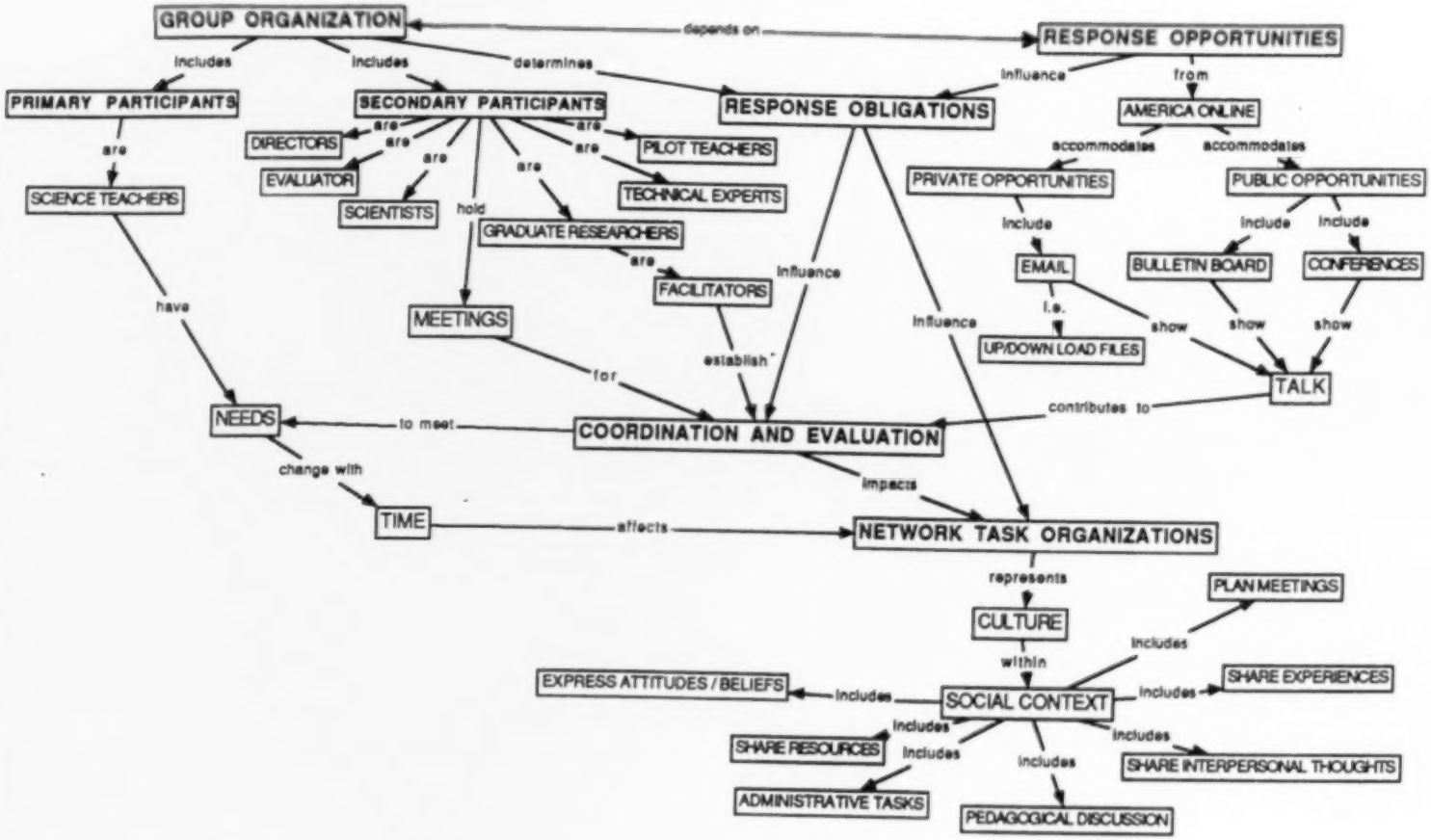

Figure 6 A summary of the interactions that occurred in this community.

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